

N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM
MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT
CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED
IN THE INTEREST OF MAKING AVAILABLE AS MUCH
INFORMATION AS POSSIBLE

BIBLIOGRAPHY ON CARBOHYDRATE SYNTHESIS
SELECTED WORKS
1861-1981

(NASA-CR-168553) BIBLIOGRAPHY ON
CARBOHYDRATE SYNTHESIS. SELECTED WORKS,
1861 - 1981 (George Washington Univ.) 25 p
HC A02/MF A01

N82-18871

CSCL 07C

63

54

Unclas
13568

July 1981

Patricia A. Dufour
Department of Medical and Public Affairs
Science Communication Division
The George Washington University Medical Center
Washington, D.C. 20037



PREFACE

This bibliography was originally prepared for the NASA Sponsored Workshop on Carbohydrate Synthesis in a Controlled Ecological Life Support System (CELSS) at the Belmont Conference Center (Elkridge, Maryland), June 23-27, 1981.

The citations are arranged alphabetically by author in the following sections:

- I. Chemistry, Experimental and Industrial
- II. Application to Space Travel and Feeding Studies
- III. Hardware
- IV. Reviews

TABLE OF CONTENTS

I.	Chemistry, Experimental and Industrial.....	1
II.	Application to Space Travel and Feeding Studies....	16
III.	Hardware.....	18
IV.	Reviews.....	19

BIBLIOGRAPHY ON CARBOHYDRATE SYNTHESIS
SELECTED WORKS
1861 - 1981

Patricia A. Dufour
Department of Medical and Public Affairs
Science Communication Division
The George Washington University Medical Center
Washington, D.C., U.S.A.

I. Chemistry, Experimental and Industrial

1. Achmatowicz, O., Jr., P. Bukowski, B. Szechner, Z. Zwierzchowska, and A. Zamojski. Synthesis of methyl 2,3-dideoxy-DL-alk-2-enopyranosides from furan compounds. General approach to the total synthesis of monosaccharides. Tetrahedron 27(10): 1973-1996, 1971.
2. Adams, J.L., J. Billingham, and J. Shapira. Comparison of proposed methods for the in vitro synthesis of edible carbohydrates. Pages 225-251 In: Olson, A.C. and C.L. Cooney (eds.). Immobilized Enzymes in Food and Microbial Processes, Proceedings of a Symposium 1973 Plenum, New York, NY, 1974.
3. Anand, K.S. and R.P. Puri. Kinetics of catalytic hydrolysis of dextrin by hydrogen ion exchangers. Journal of the Proceedings of the Institute of Chemists (India) 29: 79-84, 1957.
4. Ando, T. and S. Shioi. Total syntheses of carbohydrates. I. 1,3-dihydroxy-2-propanone and DL-glycero-tetrol. Bulletin of the Chemical Society of Japan 45(8): 2611-2615, 1972.
5. Aso, K., K. Shibasaki, T. Watanabe, and F. Yamauchi. Sugars in acid and enzyme hydrolysates of polysaccharides. III. Sugar composition of commercial sirups produced by acid or enzyme hydrolysis of sweet-potato starch. Tohoku Journal of Agricultural Research 11: 245-254, 1960.
6. Baer, H.H. and H.O.L. Fischer. Cyclization of dialdehydes with nitromethane. III. Preparation of 3-amino-3-deoxy-D-mannose. Journal of the American Chemical Society 82: 3709-3713, 1960.
7. Balezin, S.A. and E.K. Surykina. Chromatographic method for identifying the condensation products of formaldehyde into sugars. Uchenye Zapiski Moskovskii Gosudarstvennyi Pedagogicheskii Institut im. V.I. Lenina 99, Kafedra Obshchei i Anal. Khimii 1957(6): 159-165, 1957.

8. Barfoed, H. Use of enzymes in the preparation of dextrose and other hydrolytic products from starch. Staerke 19(1): 2-8, 1967.
9. Bassham J.A. and G.H. Krause. Free energy changes and metabolic regulation in steady state photosynthetic carbon reduction. Biochimica et Biophysica Acta 189: 207-221, 1969.
10. Berezovskii, V.M. Transformation and synthesis of carbohydrates. XII. Reduction of aldonolactones. Zhurnal Obshchei Khimii 25: 757-760, 1955.
11. Berezovskii, V.M. and E.P. Rodionova. Transformations and synthesis of carbohydrates. XIV. Steric hindrance in azo coupling of arylglucamines. Zhurnal Obshchei Khimii 26: 745-750, 1956.
12. Berezovskii, V.M. and L.I. Strel'chunas. Transformation and synthesis of carbohydrates. XI. Oxidation of ketoses. Journal of General Chemistry of the USSR 24: 855-858, 1954.
13. Berlin, A.A., O.V. Krylov, and Yu.Ye. Sinyak. (Institute of Medical-Biological Problems). Carbohydrates by the condensation of formaldehyde. U.S.S.R. Patent #280, 488 (Cl.B 01j), September 3, 1970.
14. Berlin, A.A., O.V. Krylov, and Yu.Ye. Sinyak. Effect of rare-earth metal hydroxides on formaldehyde condensation to sugars. Kosmicheskaya Biologiya i Meditsina 5(1): 33-36, 1971.
15. Bolotova, A.K. and V.I. Sharkov. [Chemical] changes in cellulose during its conversion into an easily hydrolyzed state by a mechanochemical method. Sbornik Trudov, Gosudarstvennyi Nauchno-Issledovatel'skii Institut Gidroliznoi i Sul'fitno-Spirtovoi Promyshlennosti 15: 176-188, 1966.
16. Butlerow, A. Bildung einer zuckerartigen Substanz durch Synthese. Justus Liebigs Annalen der Chemie 120: 295-298, 1861.
17. Castells, J., F. Geijo, and F. Lopez-Calahorra. The formoin reaction -- a promising entry to carbohydrates from formaldehyde. Tetrahedron Letters 21(47): 4517-4520, 1980.
18. Dacier, L.J. CH_2O and polysaccharides from the decomposition products of CO_2 and water. Belgian Patent # 445, 857, July 31, 1942.

19. De Padilla, F.H. and F.H. Hoskins. Hydrolytic conversion of sawdust into metabolizable sugars. Journal of Agricultural Food Chemistry 16(5): 735-737, 1968.
20. Depezay, J.C., A. Dureault, and M. Saniere. Branched sugars. Part 2. Stereospecific synthesis of 4-deoxy-tetroses and carbon-2 branched D-xylo- and D-arabino-pentoses. Carbohydrate Research 83(2): 273-286, 1980.
21. de Temmerman, M.C.T. Synthetic sugar. French Patent # 933, 537, April 23, 1948.
22. Detrick, R.W. Sugar units percentage, viscosity and degree of polymerization, accessibility, and other data on the ICCA standard pulps. Tappi 43: 552-554, 1960.
23. Dobrev, St., T. Sokolov, and E. Vidimski. Combined inversion of a hydrolyzate mass with pentose hydrolysis of bagasse. Khranitelna Promishlenost 22(1): 22-27, 1973a.
24. Dobrev, S., T. Sokolov, and E. Vidimski. Hydrolysis of bagasse with concentrated sulfuric acid at low ratios. Khranitelna Promishlenost 22(2): 19-24, 1973b.
25. Dudkin, M.S., N.G. Shkantova, N.S. Skornyakova, and N.A. Lemle. Analysis and kinetics of hydrolysis of polysaccharides of certain agricultural waste products. Latvijas PSR Zinatnu Akademijas Vestis, Kimijas Serija 607-617, 1962.
26. Dyankov, As.Iv., T.Iv. Ekimova, and R.K. Bichev. Conditions for the hydrolysis of corncobs. Khimiya i Industriya (Sofia) 1968(1): 20-24, 1968.
27. Edwards, L. and S.E. Norberg. Alkaline delignification kinetics. General model applied to oxygen bleaching and kraft pulping. Tappi 56(11): 108-111, 1973.
28. Ewart, A.J. The synthesis of sugars from formaldehyde, carbon dioxide and water. Proceedings of the Royal Society of Victoria 31(2): 378-387, 1919.
29. Fagan, R.D., H.E. Grethlein, A.O. Converse, and A. Porteous. Kinetics of the acid hydrolysis of cellulose found in paper refuse. Environmental Science and Technology 5(6): 545-547, 1971.
30. Fulmer, E.I., J.W. Dunning, and R.H. Fash (to Anderson, Clayton & Co.). Converting cellulose into sugar. United States Patent # 2, 426, 677, September 2, 1947.

31. Gabel, N.W. and C. Ponnampereuma. Model for origin of monosaccharides. Nature 216: 453-455, November 4, 1967.
32. Ganti, T. Primeval ocean in a test tube. I. Origin of organic compounds with small molecules. Termesztudományok 99(9): 413-415, 1968.
33. Garg, H.G. Application of the aldehyde-nitroalkane procedure to carbohydrate chemistry. Journal of Scientific and Industrial Research 28(7): 254-257, 1969.
34. Ghose, T.K. United States Patent # 3642580.
35. Ghose, T.K. Continuous enzymatic saccharification of cellulose with culture filtrates of *Trichoderma viride* QM 6a. Biotechnology and Bioengineering 11: 239-261, 1969.
36. Ghose, T.K. and J.A. Kostick. Enzymatic saccharification of cellulose in semi and continuous agitated systems. Advances in Chemistry Series 95: 415-446, 1969.
37. Ghose, T.K. and J.A. Kostick. A model for continuous enzymatic saccharification of cellulose with simultaneous removal of glucose syrup. Biotechnology and Bioengineering 12(6): 921-946, 1970.
38. Goodman, L., E.M. Acton, C.W. Mosher, and J.P. Marsh, Jr. Methoxymercuration in synthetic carbohydrate chemistry. Methyl 2,6-dideoxy- α -L-arabino-hexopyranoside. Methods in Carbohydrate Chemistry 8: 207-209, 1980.
39. Gorokhov, Y.B., A.N. Surzhenk, E.A. Shamansk, and N.P. Evmenk. Effect of added metal oxides and pH on condensation of formaldehyde to carbohydrates on a lead catalyst. Kinetics and Catalysis 17(4): 821-824, 1976.
40. Grathlein, H.E. Acid hydrolysis of refuse. Biotechnology and Bioengineering Symposium 5 (Cellulose as a Chemical and Energy Resource): 303-318, 1975.
41. Haq, S. and W.J. Whelan. Chemical syntheses. Nature 178: 1222-1223, 1956.
42. Harsch, G., W. Voelter, and H. Bauer. Formose reactions. I. Kinetics and mechanism of secondary reaction step in presence of formaldehyde. Zeitschrift für Naturforschung Part B - Anorganische Chemie Organische Chemie 32(7): 826-832, 1977.

43. Higgins, F.H. New sugars from the test tube. Sugar Journal 9(2): 14-17, 1946.
44. Jones, J.K.N. and R.B. Kelly. Syntheses of sugars from smaller fragments. X. Synthesis of L-glucoheptulose. Canadian Journal of Chemistry 34: 95-97, 1956.
45. Jones, J.K.N. and H.H. Sephton. Synthesis of sugars from simpler substances. XII. Synthesis of D-glycero-D-altro-, L-glycero-L-galacto-, D-glycero-L-gluco-, and D-glycero-L-galacto-octulose. Canadian Journal of Chemistry 38: 753-760, 1960.
46. Katkevich, Yu.Yu., R.G. Katkevich, S. Perkone, D. Liepina, and R. Zeltins. Hydrolysis of polysaccharides of lignified plant materials by an enzymic complex isolated from a *Trichoderma lignorum* culture. Khimiya Drevesiny 1978(4): 82-87, 1978.
47. Katz, M. and E.T. Reese. Production of glucose by enzymatic hydrolysis of cellulose. Applied Microbiology 16: 419-420, 1968.
48. Khomenko, T.I., O.A. Golovina, M.M. Sakharov, O.V. Krylov, and A.H. Weiss. On the mechanism of autocatalysis in carbohydrate synthesis from formaldehyde. Reaction Kinetics and Catalysis Letters 13(4): 407-412, 1980.
49. Khomenko, T.I., O.A. Golovina, V.A. Seleznev, M.M. Sakharov, O.V. Krylov, R.D. Partridge, S.S. Ziemecki, and R.G. Socha. On the step scheme of the mechanism of formose synthesis in the presence of alkaline earth hydroxide catalysis. Paper presented at the Third Soviet-American Symposium on Catalysis, Snowmass Village, Colorado, June 22-25, 1977.
50. Kochetkov, N.K. An approach to the synthesis of regular polysaccharides. Izvestiya po Khimii 12(3): 489-499, 1979.
51. Kolesnik, L.V. and I.L. Shul'gina. Mechanism of the condensation of formaldehyde into carbohydrates. Pages 137-138 In: Gazenko, O.G. (ed.). Aktual'nye Voprosy Kosmicheskoi Biologii i Meditsiny. Institute of Medical-Biological Problems, Moscow, USSR, 1971.
52. Kornienko, T.P., A.N. Surzhenko, Ya.B. Gorokhovatskii, Yu.Ye. Sinyak, and V.A. Uspenskaya. Condensation of formaldehyde into carbohydrates in the presence of lead oxide. Kinetika i Kataliz 13(4): 977-981, 1972.

53. Korshak, V.V. Advances in synthesis of high-molecular compounds. Vysokomolekulyarnye Soedineniya Section A 18(7): 1443-1459, 1976.
54. Kozlova, L.V. and N.V. Chalov. Effect of the concentration of acid on the compositions of compounds of sulfuric acid with products of the hydrolysis of cellolignin polysaccharides. Gidroliznaya i Lesokhimicheskaya Promyshlennost 1973(8): 3-5, 1973.
55. Krylov, O.V., Yu.Ye. Sinyak, V.A. Uspenskaya, and I.L. Shul'gina. Catalytic synthesis of carbohydrates from formaldehyde. Kosmicheskaya Biologiya i Meditsina 4(1): 6-11, 1970.
56. Kyowa Fermentation Industry Co., Ltd. Production of carbohydrates from hydrocarbons. French Patent # 1, 508, 912 (Cl.C 13k), January 5, 1968a.
57. Kyowa Fermentation Industry Co., Ltd. Carbohydrate production by fermentation of hydrocarbons. French Patent # 1, 530, 165 (Cl.C 12d), June 21, 1968b.
58. Lemmon, R.M. Prebiological synthesis. Contemporary Physics 14(5): 463-477, 1973.
59. Likholobov, V.A., A.H. Weiss, and M.M. Sakharov. Use of temperature to simplify formose sugar composition. Reaction Kinetics and Catalysis Letters 8(2): 155-166, 1978.
60. Likholobov, V.A., A.H. Weiss, M.M. Sakharov, and Y.I. Ermakov. Study of the catalytic activity of Cr(III) complexes in the reaction of condensation of formaldehyde into carbohydrates. Paper presented at the Fifth Soviet-American Symposium on Catalysis, Baku, USSR, May 17, 1978.
61. Likhonos, E.F. and I.I. Korol'kov. Inversion of wood hydrolyzates. Gidroliznaya i Lesokhimicheskaya Promyshlennost 18(6): 3-4, 1965.
62. Lindsey, R.R. and C.R. Wilke (Lawrence Berkeley Laboratory, University of California, Berkeley, CA, USA). Process design and optimization of cellulose hydrolysis. Report # LBL-7864 (avail. NTIS), 131 pages, 1978.
63. Loeb, W. and G. Pulvermacher. Sugar decompositions. Synthesis of sugar from formaldehyde. Biochemische Zeitschrift 26: 231-237.
64. Ludvig, L. Glucose production of enzymes. Elelmezesi Ipar 23(4): 124-126, 1969.

65. Mandels, M. and J. Weber. The production of cellulases. Advances in Chemistry Series 95: 391-413, 1969.
66. Mandels, M., J. Kostick, and R. Parizek. Enhanced cellulase production by a mutant of *Trichoderma viride*. Applied Microbiology 21: 152-154, 1971a.
67. Mandels, M., J. Kostick, and R. Parizek. The use of adsorbed cellulase in the continuous conversion of cellulose to glucose. Journal of Polymer Science Part C No. 36: 445, 1971b.
68. Marshall, D.L. (Battelle Memorial Institute). Immobilized Phosphorylase for Synthesis of Polysaccharides from Glucose. NASA Report ARC-10680, September 1972.
69. Mimaki, K., M. Masunari, G. Nakaminami, and M. Nakagawa. Total syntheses of carbohydrates. III. DL-Glycer-aldehyde and 2-deoxy-DL-erythro-pentose. Bulletin of the Chemical Society of Japan 45(8): 2620-2624, 1972.
70. Minachev, K.M. and O.V. Bragin. Catalytic synthesis and reactivity of organic compounds under catalytic condition. Kinetics and Catalysis 18(1): 16-26, 1977.
71. Mizuno, T. Studies on the synthesis and utilization of formose. Part I. Sugar formation by the formaldehyde condensation in the presence of inorganic or organic bases. Nippon Nogei Kagaku Kaishi 44(7): 324-331, 1970.
72. Mizuno, T. Synthesis and utilization of formose. VI. Pathway of sugar formation during formose reaction. Shizuoka Daigaku Nogakubu Kenkyu Hokoku 1974 24: 49-61, 1975.
73. Mizuno, T., et al. Studies on synthesis and utilization of formose. Part II. Chromatographic fractionation and identification of formose sugar. Nippon Nogei Kagaku Kaishi 45: 344-350, 1971.
74. Mora, P.T. and J.W. Wood. Synthetic polysaccharides. I. Polycondensation of glucose. Journal of the American Chemical Society 80: 685-692, 1958.
75. Mora, P.T., E. Merler, and P. Maury. Synthetic polysaccharides. IV. Preparation of carboxyl derivatives of polyglucose. Journal of the American Chemical Society 81: 5449-5451, 1959.

76. Mora, P.T., J.W. Wood, and V.W. McFarland. Synthetic polysaccharides. V. Polymerization of various aldoses. Journal of the American Chemical Society 82: 3418-3421, 1960.
77. Morozov, A.A. and O.E. Levanera. Kinetics of formaldehyde condensation in the presence of aroylcarbinols. Kinetics and Catalysis 19(3): 458-460, 1978.
78. Nakaminami, G., S. Shioi, Y. Sugiyama, S. Isemura, M. Shibuya, and M. Nakagawa. Total syntheses of carbohydrates. IV. 2-Deoxy-DL-, L-, and D-erythro-pentoses and related sugars. Bulletin of the Chemical Society of Japan 45(8): 2624-2634, 1972.
79. Neubauer, M. Production of monoses. Hungarian Patent # 131, 784, July 1, 1943.
80. Nishimura, M. Waste water treatment by membrane in the food industry processes. Shokuhin Kogyo 17(14): 20-28, 1974.
81. Obata, H., K. Shikata, and T. Tokuyama. Formation of triose reductone from formaldehyde and calcium-oxide. Journal of the Agricultural Chemical Society of Japan 50(12): 593-598, 1976.
82. Ocampo, G., R. Blanco, R. Suarez, L. Draganov, T. Sokolov, and V. Kostov. Chemical hydrolysis of bagasse on an industrial scale. Cuba Azucar (Oct-Dec), 19-25, 1976.
83. Otani, Y. and S. Takahashi. Improvement of alcohol mash. XXIV. Saccharification of limit dextrans by amylases. Hakko Kogaku Zasshi 38: 123-125, 1960.
84. Panasyuk, V.G. and L.V. Podobaeva. Carbohydrates of cotton plant husks by stepwise hydrolysis. Zhurnal Prikladnoi Khimii 22: 145-156, 1949.
85. Partridge, R.D., A.H. Weiss, and D. Todd. Branched-chain carbohydrate structures resulting from formaldehyde condensation. Carbohydrate Research 24(1): 29-44, 1972.
86. Partridge, R.D., T.I. Khomenko, O.A. Golovina, and M.M. Sakharov. Kinetics and selectivity of the synthesis of carbohydrates from formaldehyde in the presence of alkaline earth metal hydroxides and mechanism of autocatalysis. Kinetika i Kataliz 18(3): 557-558, 1977.
87. Pathak, C.F. and T.K. Ghose. Cellulases - 1: Sources, Technology. Process Biochemistry 8(4): 35-38, 1973.

88. Paulsen, H., V. Sinnwell, and J. Thiem. Applications of the 1,3-dithiane procedure for the synthesis of branched-chain carbohydrates. L-Streptose, methyl .beta.-D-hamameloside, methyl 2,3,6-trideoxy-2-C-(2-hydroxyacetyl)-.alpha.-L-threo-hexopyranosid-4-ulose, methyl 4-C-(2-benzoxycetyl)-2,3,6-trideoxy-.alpha.-L-threo-hexopyranoside. Methods in Carbohydrate Chemistry 8: 185-194, 1980.
89. Pavlova, T.A., N.I. Kuibina, and V.I. Sharkov. Water-soluble fraction of sunflower hull hemicelluloses. Khimiya Drevesiny 1972(12): 59-66, 1972.
90. Petropavlovskii, G.A., G.M. Mikhailov, and G.G. Vasil'eva. Differential thermograms of cellulose. Cellular Chemistry and Technology 6(6): 617-626, 1972.
91. Pfeil, E. and H. Ruckert. Formaldehyde condensation. Formation of sugars from formaldehyde by the action of alkalies. Annalen der Chemie, Justus Liebig's 641: 121-131, 1961.
92. Putnina, M. and P. Odincovs. Procedure for the preparation of highly concentrated sugar solutions. Latvijas PSR Zinatnu Akademija Mezaimniecibas Problemu Instituta Raksti 13: 5-8, 1957.
93. Rendleman, J. Complexes of alkali metals and alkaline-earth metals with carbohydrates. Pages 209-271 In: Wolfrom, M.L. and R.S. Tipson (eds.). Advances in Carbohydrate Chemistry. Volume 21. Academic Press, New York, 1966.
94. Richardson, A.C. and Fischer, H.O.L. Cyclizations of dialdehydes with nitromethane. V. Preparation of some 3-amino-1,6-anhydro-3-deoxy- β -D-hexoses and the elucidation of their structures. Proceedings of the Chemical Society 341-342, 1960.
95. Rodda, E.D. Systems design study for food production by nonagricultural methods. Transactions of the ASAE 17(3): 553-556, 1974.
96. Roy, N. and A. Mitra. Synthesis of 2,3-epoxypropyl β -D-xylopyranoside and 1,5-anhydroxylitol. Carbohydrate Research 24: 173-182, 1972.
97. Rozenfel'd, M.G., et al. Synthesis of methanol from carbon dioxide and hydrogen for reproducing artificial sugars. Space Biology and Aerospace Medicine 8(1): 67-74, 1974a.

98. Rozenfel'd, M.G., et al. Synthesis of methanol from CO₂ and H₂ as an intermediate product of carbohydrate production. Space Biology and Aerospace Medicine 8(2): 36-42, May 1974b.
99. Runge, K. and R. Mayer. Plant components. XIII. Carbohydrates from formaldehyde in the presence of tertiary amines. Justus Liebig's Annalen der Chemie 707: 161-169, 1967.
100. Rutkowski, J. Sulfite pulping process conducted by drawing off and recycling a portion of cooking liquor. Prace Instytutu Celuloz-Papier No.1, 15 pages, 1955.
101. Sapotnitskii, S.A. and A.G. Moskaleva. Effect of aldehydes on the solution of polysaccharides and the formation of sugars in the sulfite digestion of chlorocellulose. Zhurnal Prikladnoi Khimii 33: 1168-1172, 1960.
102. Schenck, R. Light in the process of synthesis of carbohydrates. Strahlentherapie 103: 165-174, 1957.
103. Schläpfer, P. and H.C. Silberman. Sugars prepared by saccharification of cellulose of cellulosic material containing hexosans or pentosans. Swiss Patent # 341, 459, November 14, 1959.
104. Secrist, J.A., III, and S.-R. Wu. Construction of long-chain carbohydrates. Synthesis and chemistry of a galactose 6-phosphorane. Journal of Organic Chemistry 44(9): 1434-1438, 1979.
105. Shapira, J. Identification of sugars as their trifluoroacetyl polyol derivatives. Nature 222: 792-793, 1969.
106. Sharkov, V.I. and V.P. Levanova. Kinetics of hydrolysis [of polysaccharides] and the influence of salts. Gidroliznaya i Lesokhimicheskaya Promyshlennost 10(6): 8-10, 1957.
107. Shibasaki, K. and K. Aso. Sugars in the acid hydrolyzates of polysaccharides. II. Sugars in the hydrolyzate of wood with concentrated sulfuric acid. Nippon Nogei Kagaku Kaishi 31: 1-4, 1957.
108. Shigemasa, Y. New aspects of formose reaction. Journal of Synthetic Organic Chemistry Japan 36(8): 667-683, 1978.
109. Shigemasa, Y., S. Akagi, R. Nakashim, and S. Saito. Formose reactions. 10. A selective synthesis of 2,4-di-C-(hydroxymethyl)-3-pentulose in the formose reaction. Carbohydrate Research 80(1): C1-C3, 1980.

110. Shigemasa, Y., T. Fujitani, C. Sakazawa, and T. Matsuura. Formose reactions. III. Evaluation of various factors affecting the formose reaction. Bulletin of the Chemical Society of Japan 50(6): 1527-1531, 1977.
111. Shigemasa, Y., M. Kawahara, C. Sakazawa, R. Nakashim, and T. Matsuura. Formose reactions. 9. Selective formation of branched sugar alcohols in a modified formose reaction and factors affecting the selectivity. Journal of Catalysis 62(1): 107-116, 1980.
112. Shigemasa, Y., O. Nagae, C. Sakazawa, R. Nakashim, and T. Matsuura. Formose reactions. 5. Selective formose reaction. Journal of the American Chemical Society 100(4): 1309-1310, 1978.
113. Sihtola, H. and L. Lamanen. Influence of hot alkali treatment on the reducing end units of cellulose in the light of model experiments with cellobiose. Cellulose Chemistry and Technology 3(1): 3-8, 1969.
114. Smiley, K.L. Continuous conversion of starch to glucose with immobilized glucoamylase. Biotechnology and Bioengineering 13(2): 309-317, 1971.
115. Socha, R.F., A.H. Weiss, and M.M. Sakharov. Auto-catalysis in the formose reaction. Reaction Kinetics and Catalysis Letters 14(2): 119-128, 1980.
116. Socha, R.F., A.H. Weiss, and M.M. Sakharov. Homogeneously catalyzed condensation of formaldehyde to carbohydrates. VII. An overall formose reaction model. Journal of Catalysis 67(1): 207-217, 1981.
117. Sonogashira, K. and M. Nakagawa. Total syntheses of carbohydrates. II. DL-Erythrose and DL-threose. Bulletin of the Chemical Society of Japan 45(8): 2616-2620, 1972.
118. Spano, L.A., J. Medeiros, and M. Mandels. Enzymic hydrolysis of cellulosic wastes to glucose. Resource Recovery and Conservation 1(3): 279-294, 1976.
119. Starichkova, V.E. and M.S. Dudkin. Interaction of hydrochloric acid solutions with cornstalk and millet hull hemicelluloses. Khimiya Drevesiny 3: 27-32, 1969.
120. Strandberg, G.W. and K.L. Smiley. Free and immobilized glucose isomerase from Streptomyces phaeochromogenes. Applied Microbiology 21: 588-593, 1971.
121. Surzhenko, A.N., T.P. Kornienko, and Ya.B. Gorokhovatskii. Mechanism of formaldehyde condensate into carbohydrates in the presence of lead oxide. Kataliz i Katalizatory 1971(8): 81-83. 1971.

122. Takahata, H., T. Kunieda, and T. Takizawa. Synthetic routes to carbohydrates by use of telomers of vinylene carbonate with polyhalomethanes. Chemical and Pharmaceutical Bulletin 23(1): 3017-3026, 1975.
123. Tambawala, H. and A.H. Weiss. Homogeneously catalyzed formaldehyde condensation to carbohydrates. 2. Instabilities and cannizzaro effects. Journal of Catalysis 26(3): 388-400, March 1972.
124. Tidwell, L., J. Lecocq, H.B. Chermiside, and J. Shapira. Extraction of some components of formose sugar mixtures by enzymic methods. Proceedings of the Western Pharmacology Society 13: 30-33, 1970.
125. Toyama, N. Microbial utilization of cellulosic wastes. Kami Pa Gikyoshi 30(5): 245-251, 1976a.
126. Toyama, N. Feasibility of sugar production from agricultural and urban cellulosic wastes with *Trichoderma viride* cellulase. Biotechnology and Bioengineering Symposium 6(Enzym. Convers. Cellul. Mater.: Technol. Appl. Symp. Proc., 1975): 207-219, 1976b.
127. Udic Soci  t   anon. Polyhydric alcohol preparation by hydrogenation of sugars from hydrolysis of vegetable materials. British Patent # 838, 766, June 22, 1960.
128. Uskov, Yu.N. and N.V. Chalov. Mechanochemical degradation of lignocellulose polysaccharides in the presence of phosphoric acid. Gidroliznaya i Lesokhimicheskaya Promyshlennost 1974(7): 5-6, 1974.
129. Uspenskaya, V.A., O.V. Krylov, and Yu.Ye. Sinyak. Effect of monosaccharides on condensation of formaldehyde to carbohydrates. Kosmicheskaya Biologiya i Meditsina 5(4): 9-16, 1971.
130. Uyeno, Y. and S. Kitaura. The precipitation of lignosulfonic acid from spent sulfite liquor by calcium hydroxide. Parupu Kami Kogyo Zasshi 12: 523-526, 1958.
131. Vasyunina, N.A. Hydrolytic hydrogenation of polysaccharides and the multiplet theory of catalysis. V. Catalysis and Chemical Kinetics 1964: 75-83, 1964.
132. Vasyunina, N.A., S.V. Chepigo, and G.S. Barysheva. Hydrolytic hydrogenation of hemicelluloses. Sbornik Trudov, Gosudarstvennyi Nauchno-Issledovatel'skii Institut Gidroliznoi i Sul'fitno-Spirtovoi Promyshlennosti 12: 180-184, 1964.

133. Wallace, L.C., R.C. Sproull, and D.L. Kenaga (25% to Tennessee Coal & Iron Division, United States Steel Corp. and 75% to Nickey Brothers, Inc.). Hydrolyzing cellulosic materials. United States Patent # 2,739,086, March 20, 1956.
134. Weiss, A.H. A process for the synthesis of ethylene glycol from formaldehyde. Paper presented at the Fifth Soviet-American Symposium on Catalysis, Baku, USSR, May 18, 1978.
135. Weiss, A.H. and T. John. Homogeneously catalyzed formaldehyde condensation to carbohydrates. 3. Concentration instabilities, nature of catalyst, and mechanisms. Journal of Catalysis 32(2): 216-229, February 1974.
136. Weiss, A.H. and S. Trigerma. Zinc oxide as a formose catalyst. Reaction Kinetics and Catalysis Letters 14(3): 259-263, 1980.
137. Weiss, A.H., T.I. Golovina, and T.I. Khomenko. About some specifics of kinetics and mechanism of formose synthesis in the presence of alkaline earth metal hydroxides. Kinetika i Kataliz 18(4), 1977.
138. Weiss, A.H., R.B. LaPierre, and J. Shapira. Homogeneously catalyzed formaldehyde condensation to carbohydrates. Journal of Catalysis 16(3): 332-347, March 1970.
139. Weiss, A.H., V.A. Seleznev, and R. Partridge. Simultaneously catalyzed reactions of formaldehyde in alkaline systems. Pages 153-164 In: Smith, G.V. Catalysis in Organic Synthesis. Academic Press Inc., New York, 1977.
140. Weiss, A.H., Ya.B. Gorokhovatskiy, N.P. Evmenenko, and V.F. Gaevskiy. Investigation of complexing during formaldehyde condensation in the presence of lead catalysts. Kinetika i Kataliz 18(4): 539-542, 1977.
141. Weiss, A.H., O.V. Krylov, M.M. Sakharov, and Ya.B. Ghorochovatskii. Synthetic carbohydrates from formaldehyde. Journal of Food Processing and Preservation 2(1): 63-71, 1978.
142. Weiss, A.H., V.A. Seleznev, M.M. Sakharov, Ya.B. Gorokhovatskiy, and N.P. Evmenenko. Influence of the ambient pH and complexation in the condensation of formaldehyde to form carbohydrates. Bulletin of the Academy of Sciences of the USSR Division of Chemical Science 27(7): 1410-1415, 1978a.

143. Weiss, A.H., V.A. Seleznev, M.M. Sakharov, Ya.B. Gorokhovatskiy, and N.P. Evmenenko. Investigation of the influence of pH and complexing in reaction of formaldehyde condensation to sugars. Izvestiya An, SSSR ser. khim., July 1978b.
144. Weiss, A.H., A.H. Trigerman, G. Dunnell, V.A. Likholobov, and E. Biron. Ethylene glycol from formaldehyde. Presented at the Department of Energy Seminar Series, Pittsburgh Energy Technology Center, Brucetor, PA, January 9, 1979 and at Union Carbide R&D Laboratories, South Charleston, WV, January 22, 1979.
145. Weiss, A.H., T.I. Khomenko, O.A. Golovina, M.M. Sakharov, O.V. Krylov, and R.D. Partridge. Homogeneously catalyzed formaldehyde condensation to carbohydrates IV. Alkaline earth hydroxide catalysts used with glycolaldehyde cocatalyst. Journal of Catalysis 45: 356-366, 1976.
146. Weiss, A.H., V.A. Seleznev, M.M. Sakharov, O.V. Krylov, Ya.B. Ghorokhovatskiy, and N.P. Evmenenko. Homogeneously catalyzed condensation of formaldehyde to carbohydrates. V. Complexing and pH behavior with glucose cocatalyst. Journal of Catalysis 48: 354-364, 1977.
147. Wenghart, J. Synthesis of alcohols, sugars, starch, cellulose, hydrocarbons and proteins. French Patent # 835, 239, December 15, 1938.
148. Whistler, R.L. and C.L. Smart. Isolation of crystalline D-glucose and cellobiose from an enzymic hydrolyzate of cellulose. Journal of the American Chemical Society 75: 1916-1918, 1953.
149. Wiley, A.J., L.M. Whitmore, Jr., and L.A. Boggs. Utilization of spent sulfite liquor carbohydrates. Tappi 42(5): 14A, 16A, 22A, 24A, 26A, 1959.
150. Wilke, C.R., R.D. Yang, A.S. Sciamanna, and R.P. Freitas. (Lawrence Berkeley Laboratory, University of California, Berkeley, CA, USA). Raw materials evaluation and process development studies for conversion of biomass to sugars and ethanol. Report # LBL-7847, CONF-7806107-1 (Avail. NTIS), 41 pages, 1978.
151. Wood, J.W. and P.T. Mora. Synthetic polysaccharides. III. Polyglucose sulfates. Journal of the American Chemical Society 80: 3700-3702, 1958.

152. Yanagawa, H., Y. Kobayash, and F. Egami. Genesis of amino acids in the primeval sea formation of amino acids from sugars and ammonia in a modified sea medium. Journal of Biochemistry 87(1): 359-362, 1980.
153. Ziemecki, S.B., R.B. LaPierre, A.H. Weiss, and M.M. Sakharov. Homogeneously catalyzed condensation of formaldehyde to carbohydrates. VI. Preparation and spectroscopic investigation of complexes active in formaldehyde condensation. Journal of Catalysis 50(3): 455-463, 1977.
154. Anonymous. Simultaneous autocatalytic and non-autocatalytic formaldehyde reactions. Plenary Lecture at Third Soviet-American Symposium on Catalysis, Kiev, July 5, 1976. Kinetika i Kataliz 18(4): 539-542, 1977.

II. Application to Space Travel and Feeding Studies

1. Akerlof, G.C. Feasibility of regeneration of carbohydrates in a closed circuit respiratory system. Journal of Spacecraft & Rockets 1: 303-310, 1964.
2. Akerlof, G.C. and P.W.D. Mitchell. (FMC Corporation, Princeton, NJ). A Study of the Feasibility of the Regeneration of Carbohydrates in a Closed Circuit Respiratory System. Final Report, NASA Contract NASr-88, 1963.
3. Frankenfield, J.W. (Esso Research and Engineering Co., Linden, NJ). Study of Methods of Synthesis of Fatty Acids and Lipids from Metabolic Wastes Aboard a Space Craft. Final Technical Report, NASA Contract NAS2-3708, 1967.
4. Johnson, V., A.J. Carlson, and A. Johnson. Studies on the physiological action of glycerol on the animal organism. American Journal of Physiology 103: 517-534, 1933.
5. Mizuno, T., et al. Studies on synthesis and utilization of formose. Part III. Utilization tests of formose for animal. Nippon Nogei Kagaku Kaishi 46: 73-80, 1971.
6. National Aeronautics and Space Administration. The Closed Life Support System, Proceedings of the Conference, Ames Research Center, Moffett Field, CA, April 14-15, 1966. NASA SP-134, NASA, Washington, D.C., 1967.
7. Ramsden, H.E., W.F. Taylor, and A.H. Weiss. (Esso Research and Engineering Co., Linden, NJ). Study of Synthesis of Glycerol. Annual Report, 30 June 1967 - 30 September 1968, NASA-CR-73303, NASA Contract NAS2-4496, 1968.
8. Shapira, J. (Ames Research Center, NASA, Moffett Field, CA). Approaches to the Chemical Synthesis of Food. NASA Technical Memorandum, NASA-TM-X-59839, 22 pages, 1967.
9. Shapira, J. Space feeding: Approaches to the chemical synthesis of food. Cereal Science Today 13(2): 58-63, 1968.
10. Shapira, J. Food synthesis by physicochemical methods. Pages 133-140 In: Aerospace Food Technology, Proceedings of the Conference, St. Petersburg, FL, April 15-17, 1969 NASA SP-202, NASA, Washington, D.C., 1970.

11. Shapira, J. Use of glycerol as a diet supplement during a ninety-day manned test. Pages 269-275 In: Pearson, A.O. and D.C. Grana (comps.) Preliminary Results From an Operational 90-Day Manned Test of a Regenerative Life Support System, Proceedings of a Symposium, NASA Langley Research Center, Hampton, VA, November 17-18, 1970. NASA SP-261, NASA, Washington, D.C., 1971.
12. Shemanov, G.F., Y.E. Sinyak, and V.I. Gorshkov. Effect of synthetic carbohydrates on lysosomes of rat liver. Kosmicheskaya Biologiya i Meditsina 6(2): 29, 1972.
13. Sinyak, Yu.Ye. Physicochemical synthesis of monosaccharides from human wastes. Space Biology and Medicine 2(6): 9-20, 1968.
14. Sinyak, Yu.Ye. and V.A. Uspenskaya. Synthesis of carbohydrates from human waste products in limited closed spaces. Pages 197-202 In: Nichiporovich, A.A. and G.M. Lisovskii (eds.) Problemy Sizdaniya Zamknutykh Ekologicheskikh Sistem. Nauka, Moscow, USSR, 1967.
15. Uspenskaya, V.A. and G.M. Petrova. Efficiency of using products of formaldehyde condensation during carbohydrate synthesis. Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina 8(2): 20-24, 1974.
16. Weiss, A.H. (Worcester Polytechnic Institute, Worcester, MA). Study of the Techniques Feasible for Food Synthesis Aboard a Spacecraft. Semiannual Status Report, 1 February - 31 July 1969, NASA-CR-107632 SASR-3-SUPPL-1, NASA Contract NGR-22-017-008, 1969.
17. Weiss, A.H. (Worcester Polytechnic Institute, Worcester, MA). Study of the Techniques Feasible for Food Synthesis Aboard a Spacecraft. Final Report, NASA-CR-126397, NASA Contract NGR-22-017-008, 1972.
18. Weiss, A.H. (Worcester Polytechnic Institute, Worcester, MA). Edible Carbohydrates From Formaldehyde in a Spacecraft. Final Report, 1 July 1974 - 31 December 1975, NASA-CR-146639, 23 pages, 1975.

III. Hardware

1. Dubey, G.A., T.R. McElhinney, and A.J. Wiley. Processing of pulping spent liquors by electrodialysis. Membrane Processes for Industry, Proceedings of the Symposium, Birmingham, AL pages 61-79, 1966.
2. Kalnina, V., P. Odincovs, Ch.A. Sobolevskii, and D. Pelsis. Hydrolysis of plant raw material with small amounts of H_2SO_4 on a roller hydrolysis machine. Trudy Instituta Lesokhozyaistvennykh Problem, Akademiya Nauk Latvii SSR 17: 37-44, 1959.
3. Peters, M.S. and K.D. Timmerhaus. Plant Design and Economics for Chemical Engineers. 2nd ed. McGraw-Hill, New York, 1968,
4. Weiss, A.H. and J. Shapira. Manufacture of sugars. Chemical Engineering Progress, Symposium Series 67(108): 137-147, 1971.
5. Zagorul'ko, A.Ya. Continuous-operation membrane reactor. Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Sakharnoi Promyshlennosti 17: 185-199, 1971.

IV. Reviews

1. Babbar, I.J. Food and energy from cellulosic wastes. Chemical Age of India 26(7): 505-511, 1975.
2. Berman, G.A. and K.H. Murashige (eds.). Synthetic Carbohydrate, An Aid to Nutrition in the Future. Prepared under Stanford University Ames Research Center Summer Faculty Program in Engineering Systems Design. NASA Contract NGR-05-020-409, School of Engineering, Stanford University, 1972.
3. Broeg, C.B. and R.D. Moroz. Sugar and starch. Pages 488-513 In: James, K. (ed.). Handbook of Industrial Chemistry, 7th ed. A. Van Nostrand-Reinhold, New York, NY, 1974.
4. Demishev, V.N., N.B. Berlin, L.A. Sadovnikova, and Yu.Ye. Sinyak. Catalysts for formaldehyde condensation. Sinteticheskie Polielektrolity i Polimernye Dispersnye Sistemy 1973: 12-16, 1973.
5. El Khadem, H.S. (ed.) ACS Symposium Series, Vol. 39: Synthetic Methods for Carbohydrates. American Chemical Society, Washington, D.C., 285 pages, 1976.
6. Fiorenzi, G. The production of starch with new characteristics. Quaderni Merceologia 1(1): 173-195, 1962.
7. Ghose, T.K. and A.N. Pathak. Cellulose - a source of future food. Indian Chemical Engineer 17(4): 3-16, 1975.
8. Heyns, K. Carbohydrate technology. Pages 589-648 In: Winnacker, K. and L. Kuechler (eds.). Chemische Technologie, 3. Neubearbeitete Auflage. Carl Hanser Verlag, Munich, Germany, 1971.
9. Jones, J.K.N. and W.A. Szarek. Total synthesis of carbohydrates. Pages 1-80 In: ApSimon, J. (ed.). Total Synthesis of Natural Products Volume 1. Wiley, New York, NY, 1973.
10. Kennedy, J.F. Chemical synthesis and modification of oligosaccharides, polysaccharides, glycoproteins, enzymes, and glycolipids. Carbohydrate Chemistry 7: 496-585, 1975.
11. Kennedy, J.F. Macromolecules. 8. Chemical synthesis and modification of oligosaccharides, polysaccharides, glycoproteins, enzymes, and glycolipids. Carbohydrate Chemistry 11: 445-513, 1979.

12. Khomenko, T.I., M.M. Sakharov, and O.A. Golovina. Synthesis of carbohydrates from formaldehyde. Uspek Khimii 49(6): 1079-1105, 1980.
13. King, K.W. and M.I. Vessal. Enzymes of the cellulase complex. Advances in Chemistry Series 95: 7, 1969.
14. Klopfenstein, T. and W. Koers. Agricultural cellulosic wastes for feed. Pages 38-54 In: Inglett, G.F. (ed.). Symposium: Processing Agricultural and Municipal Wastes, New York, August 27-28, 1972. Avi, Westport, Conn, 1973.
15. Kochetkov, N.K., et al. Chemistry of carbohydrates. Khimiya, Moscow, 671 pages, 1967.
16. Korshak, V.V. and N.M. Kozyreva. Progress of the synthetic chemistry of macromolecular compounds. Uspek Khimii 48(1): 5-29, 1979.
17. Lobanova, M.A. and Yu.Ye. Sinyak. Physicochemical methods of producing formaldehyde for the synthesis of carbohydrates in life-support systems. Kosmicheskaya Biologiya i Meditsina 3(6): 11-20, 1969.
18. Mizuno, T. and A.H. Weiss. Synthesis and utilization of formose sugars. Advances in Carbohydrate Chemistry and Biochemistry 29: 173-227, 1974.
19. Nishizawa, K. Mechanism of the enzymatic decomposition of cellulose. Hakko Kogaku Zasshi 40: 150-160, 1962.
20. Norberg, T. Synthesis of some carbohydrates of biological significance. Chemical Communications, University of Stockholm No.4, 37 pages, 1979.
21. Ogawa, T. Organic synthesis using tin and silicon. Application to sugar and nucleoside chemistry. Kagaku To Seibutsu 14(10): 654-657, 1976.
22. Ogawa, T. Synthesis of carbohydrates and nucleosides by the use of organotin and organosilicon compounds. Nippon Nogei Kagaku Kaishi 52(7): R93-R101, 1978.
23. Orestov, I.L. Development of studies on the synthesis of carbohydrates from formaldehyde. Voprosy Istorii Estestvoznaniya i Tekhniki 1968(24): 56-59, 1968.
24. Pigman, W. and D. Horton (eds.). The Carbohydrates. Academic Press, New York, 1970.
25. Pigman, W.W. and M.L. Wolfrom (eds.). Advances in Carbohydrate Chemistry. Academic Press, New York, 1949.

26. Reese, E.T., M. Mandels, and A.H. Weiss. Cellulose as a novel energy source. Pages 181-200 In: Ghose, T.K., A. Fiechter, and N. Blakebrough (eds.). Advances in Biochemical Engineering Volume 2, 0.181. Springer Verlag, 1972.
27. Schuerch, C., J. Zachoval, and B. Veruovic. Synthetic linear polysaccharides. Chemicke Listy 66(11): 1124-1149, 1972.
28. Schurz, J. Biomass and chemistry. Wochenblatt fuer Papierfabrikation 107(17): 624-627, 630, 632, 1979.
29. Shoruigin, P.P. Synthesis of sugar substances. Zapiski 3: 137-160, 1926.
30. Suzuki, S. Starch hydrolyzing industry in Japan. Progress in the past decade and future prospects. Dempun Kogyo Gakkaishi 17(1): 15-74, 1969.
31. Szarek, W.A. General carbohydrates synthesis. International Review of Science: Organic Chemistry, Series One 7: 71-104, 1973.
32. Takemoto, K. On a new conception about the synthetic chemistry based on chemical syntheses as the model. Kobunshi 25(1): 42-46, 1976.
33. Taylor, A.E. On synthesis through ferment action. Zeitschrift fuer Physikalische Chemie 69: 585-597, 1909.
34. Tsao, G.T. Fermentable sugars from cellulosic wastes as a natural resource. Proceedings -- Annual Fuels Biomass Symposium 2nd 2: P571-P599, 1978.
35. Vytopil, Z. Review of chemical and photochemical syntheses of the sugars. Zeitschrift fuer die Zuckerindustrie der Cechoslovakischen Republik 49: 216-218, 1925.
36. Weiss, A.H. and J. Shapira. Sugars from formaldehyde. Hydrocarbon Processing 49(2): 119-126, 1970.
37. Weiss, A.H., R.F. Socha, V.A. Likholobov, and M.M. Sakharov. Polyols from formaldehyde. CHEMTECH US 10(10): 643-647, 1980.
38. Welsch, F. Development of ideas concerning chemical synthesis in 19th and at beginning of 20th century. Chemicke Listy 72(8): 857-870, 1978.

39. Whitmore, L.M., Jr. and A.J. Wiley. Chemical by-products from spent sulfite liquors. Chemical Engineering Progress 54(12): 80a-80d, 1958.
40. Wilke, C.R. Production of sugars and ethanol based on the enzymic hydrolysis of cellulose. Proceedings -- Fuels Biomass Symposium 1977 pages 115-144, 1978.
41. Wolfrom, M.L. and R.S. Tipson (eds.). Advances in Carbohydrate Chemistry. Academic Press, New York, 1966.
42. Woolhouse, A.D. Starch as a source of carbohydrate sweeteners. Report -- New Zealand, Department of Scientific and Industrial Research, Chemistry Division 71 pages, 1976.
43. Zamojski, A. Chemical synthesis of sugars. Chemia Stosowana 23(4): 371-389, 1979.

Acknowledgement: This work was performed under NASA Contract NASw-3165.